THE USE OF DUST RESPIRATORS IN COAL MINES

BY S. J. PEARCE

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MARCH 3, 1849

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
James Boyd, Director

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861647

March 1950

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Information Circular 7561

INTRODUCTION AND SUMMARY

Complaints have been made regarding dust respirators that may be used in coal-mining operations. Some of these complaints may be due to improper use of the respirator, inadequate knowledge of its purpose and mode of functioning, poor choice, poor fitting, or inadequate maintenance. It is hoped that this circular will answer these complaints by discussing the various factors relating to the proper use of dust respirators in general and in coal mines in particular.

It is pointed out that dust respirators are not to be used as a substitute for dust-control measures. The construction, functioning, choice, fitting, and maintenance of dust respirators are discussed.

FIELD OF USE

The function of the dust respirator is to prevent the wearer from inhaling harmful quantities of dust by removing dust from the air he inhales.

A dust respirator is not to be used as a permanent substitute for dust-control measures. It is to be used as a temporary substitute until dust-control measures can be instituted or as a protective means where dust-control measures are impracticable, as in applying rock dust in bituminous-coal mines.

The following sections of the "Federal Mine Safety Code for Bituminous-Coal and Lignite Mines in the United States"[2] emphasize the fact that every effort should be made to keep the amount of dust in the air of the working places as small as possible:

> Article VI, section 1b. Where mining operations raise an excessive amount of dust into the air, water or water with a wetting agent added to it or other effective methods shall be used to allay such dust at its source.
>
> Article IX, section 1b. Rock drilling with percussion drills shall be done wet, except as provided for in article XI, section 7g.
>
> Article XI, section 7g. Men exposed for short periods to gas, dust, fume, and mist-inhalation hazards shall were permissible respiratory equipment. When the exposure is for prolonged periods, other measures to protect workmen or to reduce the hazard shall be taken.

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[2] Bureau of Mines, Federal Mine Safety Code for Bituminous-Coal and Lignite Mines of the United States: U. S. Govt. Printing Office, July 24, 1946, 84 pp.

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CONSTRUCTION AND MODE OF FUNCTIONING

A dust respirator consists of a facepiece, which may be fitted in a dust-tight manner to the face of the wearer, and a filter or set of filters, which removes dust from the air drawn through it as the wearer inhales. The facepiece is held in place on the wearer's face by elastic headbands. Air, which the wearer exhales, leaves the facepiece through an exhalation valve, which allows air to escape readily from inside the facepiece upon exhalation but does not allow it to enter, except through the filters, upon inhalation. Most dust respirators have inhalation check valves that allow inhaled air to enter the facepiece but prevent exhaled air from passing outward through the filters. The filters are made of paper or felt. Paper filters and some felt filters are discarded after use, but most of the felt filters may be used repeatedly after having been cleaned as described later. Some dust respirators may be used with "facelets," which are knitted-cotton covers that fit over the edge of the facepiece to prevent contact between the rubber portion of the facepiece and the wearer's face.

The basic requirements for all types of respiratory protective equipment are as follows: (1) They must give adequate protection; (2) they must provide an acceptable period of protection; (3) they must be reasonably comfortable and physically convenient to wear; and (4) they must be constructed of durable materials. All of these requirements are considered by the Bureau of Mines when examining and testing a dust respirator for approval.[3] The ability of the filter to remove dust efficiently is determined by drawing known concentrations of dust to the respirator and measuring the amount that passes through the filter. The allowable leakage is based upon the amount of dust that, it has been found, a person may breathe without harmful effects. The resistance to inhalation is measured after the dust test to assure that this resistance does not exceed a pressure head equivalent to 2 inches of water when air is drawn through the filter at the rate of 3 cubic feet per minute, equivalent to the breathing rate of a man performing very strenuous exercise. This resistance is not considered to be excessive. The ability of the respirator to fit a variety of faces is determined by having persons with faces of widely varying shapes and sizes wear the respirator and test for tightness of fit, as described later in the section on fitting. Coal dust is blown at the faces of some of the test subjects wearing the respirator. A dust-tight fit is indicated by the absence of coal dust in the nose, in the sputum, and on the part of the face covered by the facepiece. An inward leaking of coal dust between the face and the facepiece usually is indicated by a streak of dust on the wearer's face at the point of leakage.

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[3] Bureau of Mines, Procedure for Testing Dust, Fume, and Mist Respirators for Permissibility: Schedule 21, August 20, 1934, 14 pp.

When dust-laden air is drawn to a filter, most of the dust is removed, and the cleaned air passes through. The dust that is retained by the filter fills up some of the pores in the filtering medium, which aids in removing a larger proportion of the dust from the dust-laden air that continues to be brought to the filter by the wearer's inhalations. In other words, the filtering efficiency of the respirator is increased as the total amount of dust retained on the filter increases. Simultaneously with this increase in efficiency, there is an increase in resistance to inhalation, or in the difficulty of breathing inward through the filter. If enough dust were removed by the filter, it would become impossible to breathe inward through it. Thus, a dust respirator that may be used for a day or more in a low or moderate concentration of dust before difficulty in breathing is noticed, may be worn for only a relatively short time in a very high concentration of dust such as might be encountered at times during rock-dust application or dry drilling. When resistance to inhalation becomes difficult, the wearer should clean or change the filter, as described later in the section on maintenance.

SELECTION

Dust respirators to be used in coal mines need protect only against silica dust, which is classified as a pneumoconiosis-producing dust, and against coal dust and nonsiliceous rock dusts, most of which are classified as nuisance dusts. Hence, respirators that have been approved by the Bureau of Mines for respiratory protection against pneumoconiosis-producing and nuisance dusts or against all dusts should be used.

Numerous dust respirators have been approved by the Bureau of Mines,[4] and these offer a wide variety of types of facepieces and filters from which the user may choose with the knowledge that they will give adequate respiratory protection. Thus, the choice should be made as to the style of facepiece and the type of filter that is desired - whether it will be a disposable paper or felt filter or a felt filter that may be cleaned and reused.

When a dust respirator is worn for the first time, many wearers remark about the difficulty of breathing through it. This is a natural reaction, which passes rather quickly as the persons continue to wear the respirator and become busy with their work. Ease of breathing through a dust respirator is not a safe criterion for judging its worth, unless it has met the approval requirements of the Bureau of Mines. It may be that filtering efficiency has been sacrificed to provide ease of breathing.

Many persons complain that respirators are not comfortable to wear, especially for long periods. Similar complaints were made about the helmets worn by our armed forces in World Wars I and II, yet the men wore them when needed because of the protection which they afforded. The same reasoning applies to a respirator. A person may not be as comfortable while wearing a respirator as when not wearing it, but he should recognize that this minor discomfort is greatly outweighed by the value of the protection the respirator

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[4] Schrenk, H. H., List of Respiratory Protective Devices Approved by the Bureau of Mines: Bureau of Mines Inf. Circ. 7444, March 1948, 14 pp., and supplements.

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affords. Different people have diametrically opposite ideas as to the degree of comfort achieved in wearing the same respirator. Thus, if one particular style of respirator is unacceptable to individual members of a group because it is considered uncomfortable, another style may be found acceptable. A step forward in obtaining respirators that workmen would wear might be made if the person responsible for purchasing the respirators were required to wear one for an entire work day, even at his desk.

FITTING

Dust respirators approved by the Bureau of Mines will give adequate respiratory protection against the contaminants for which they are designed if they are properly fitted to the face of the wearer and if they are properly maintained.

The user should read and follow the manufacturer's instructions on the respirator container. These instructions give such details as positioning the respirator on the face, adjusting the shape of the respirator, and testing for fit. These details vary with individual respirators.

The adjustable portions of most respirator facepieces are (1) a metal body, (2) a wire at the nose portion, (3) a wire extending under the respirator and upward toward the nose portion, or (4) a metal brace inside the facepiece. These adjustable parts differ with individual respirators, but all serve the same purpose, namely, they may be bent so that the facepiece conforms to the contour of the wearer's face.

In addition to the method of testing the tightness of the fit of the respirator recommended by its manufacturer, the following method may be used: (1) Put on the respirator, (2) close off the exhalation valve in such manner that it does not disturb the fit of the facepiece, (3) exhale slowly into the facepiece and note the point at which air tends to escape from beneath its edge, (4) if an appreciable pressure can be built up in the facepiece before air escapes beneath its edge, the respirator is fitted properly, (5) if outward leakage occurs readily, usually at a point between the bridge of the nose and the cheek, the respirator is not fitted properly and should be readjusted. This method works well with all dust respirators having check valves that prevent the exhaled air from passing through the filters.

To keep discomfort to a minimum, headbands should be adjusted no tighter than is necessary to obtain a dust-tight fit and yet keep the facepiece from becoming dislodged readily while working.

MAINTENANCE

One of the most common complaints made by persons who wear dust respirators, particularly in very dusty atmospheres, is that it is very difficult to breathe through them. When asked how often they clean or change the filters, a large proportion of such persons express surprise that this is necessary. As explained previously, the resistance to inhalation increases as the total amount of dust on the filter increases. After a period of use, the length of which depends on the dust concentration and the wearer's rate of breathing, the resistance to breathing will increase to a degree that is very noticeable. Such condition is a definite indication that the filter needs attention. Paper filters and some felt filters are disposable and should be discarded and replaced by fresh filters, which should be available at all times. One means of assuring their availability would be to carry them, properly wrapped, in the lunch bucket. If carried in the worker's pockets, they may become soiled, bent out of shape, or wet. Another means would be to have them available in tightly covered containers placed at strategic locations. Most felt filters may be cleaned by tapping on a solid surface and blowing off the adherent dust with clean, dry, compressed air, if available. Care should be taken not to inhale the dust that is blown off the filter. Cleaning or changing filters takes only a moment of the worker's time and will prove worthwhile in regard to the comfort of the worker and his willingness to wear the respirator.

Another source of dissatisfaction with dust respirators used in coal mines is that they become dirty, misshapen, and unsanitary after considerable use unless properly maintained. The facepiece of the respirator should be washed every day in lukewarm water and soap after the eleastic headbands and filters have been removed. If a "facelet" is used, it should be washed and dried daily. This procedure keeps the respirator clean and prolongs the life of the rubber parts by removing from them the film of oil and perspiration that accumulates from contact with the wearer's face. Some types of rubber deteriorate rapidly if not cleaned frequently and thoroughly. The facepiece should be disinfected once a week by a method recommended by the manufacturer of the respirator. If the respirator is to be used by more than one person, it should be disinfected after each use. When the respirator is re-assembled after washing or disinfection, it should be examined to see that it is in good condition, that the valves are in place and pliable, that any necessary gaskets are in place, that the filter holders are not bent out of shape, and that the filters are properly assembled with the facepiece. Any parts found to be defective should be replaced by proper parts recommended by the manufacturer.

If the cleaning, disinfection, and inspection of a dust respirator are delegated to the individual wearer, these procedures are likely to be carried out rather sporadically. Many industrial plants have adopted a system whereby the men leave their respirators at a convenient place when coming off shift. Each workman's respirator, which is marked with the wearer's name or check number, then is cleaned, dried, inspected, repaired if necessary, re-assembled, and placed in a clean place, where it may be picked up by the user for the next shift. If it is not feasible to clean the respirators between shifts, each man may be provided with two respirators, so that one may be worn while the other is being cleaned. This system of control provides an efficient means of determining the condition of the respirators and for repairing them, especially if a stock of replacement parts for the type or types of respirators being used is kept on hand.

A workman is much less reluctant to wear a clean respirator than he is to wear one that is dirty or poorly maintained.